FFAG Longitudinal Dynamics

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FFAG Longitudinal Dynamics

- Time of flight is approximately a parabolic function of energy
- Beam makes a "serpentine" path through longtudinal phase space
  - ◆ Shape characterized by dimensionless a and b parameters
- Want to minimize distortion of the longitudinal ellipse
 - ◆ Can get pretty bad
  - ◆ Don't do it at the cost of decays

Higher Harmonic RF

- Adding higher harmonics to the RF makes the RF crest flatter

- This should reduce nonlinerities coming from RF, and thus distortion

- To remove quadratic term at crest, third harmonic should be 1/8 of desired accelerating voltage

Higher Harmonic RF Computation

- Compute distortion as a function of fraction of third harmonic RF
- Minimum distortion is for third harmonic above 1/8
- Optimum third harmonic depends on a and b parameters
  - Different a and b mean different phase profile as a function of time

Distortion vs. Amount of Higher Harmonic RF
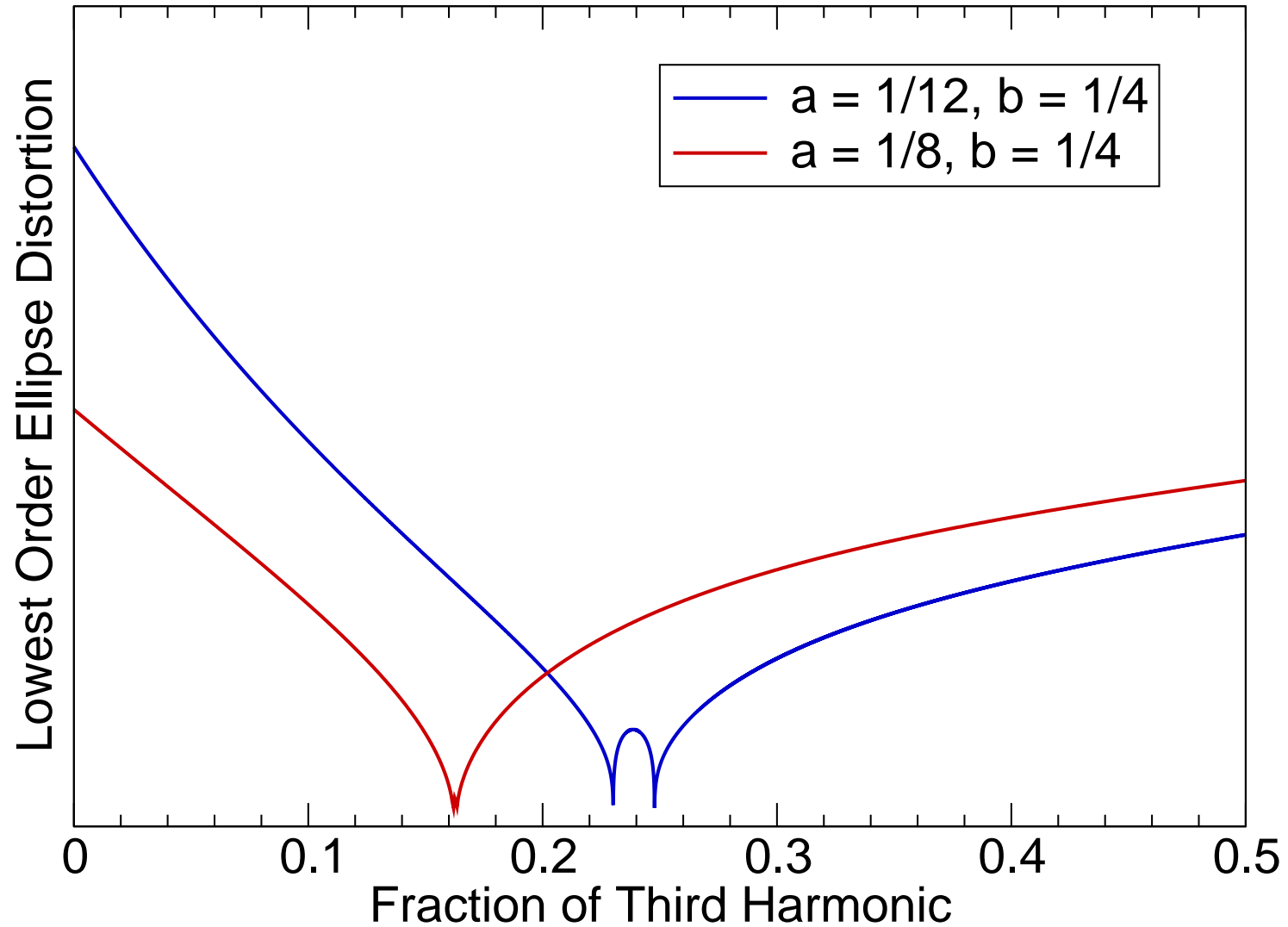
Time of Flight

- Time of flight is approximately, but not exactly, parabolic as a function of energy

- If time of flight is symmetric about minimum, optimum performance is with minimum at central energy

- Where is minimum distortion when parabola is not symmetric

  - Calculations have assumed same time of flight at minimum and maxumum energies is ideal

  - Ideal has lowest energy with higher time of flight than highest energy

    - Assumed cubic and quadratic terms were fixed, and linear term was modified

      - Oversimplification: could do correctly, but much slower process

    - This configuration likely results in slightly reduced apertures

Optimum Time of Flight Parabola
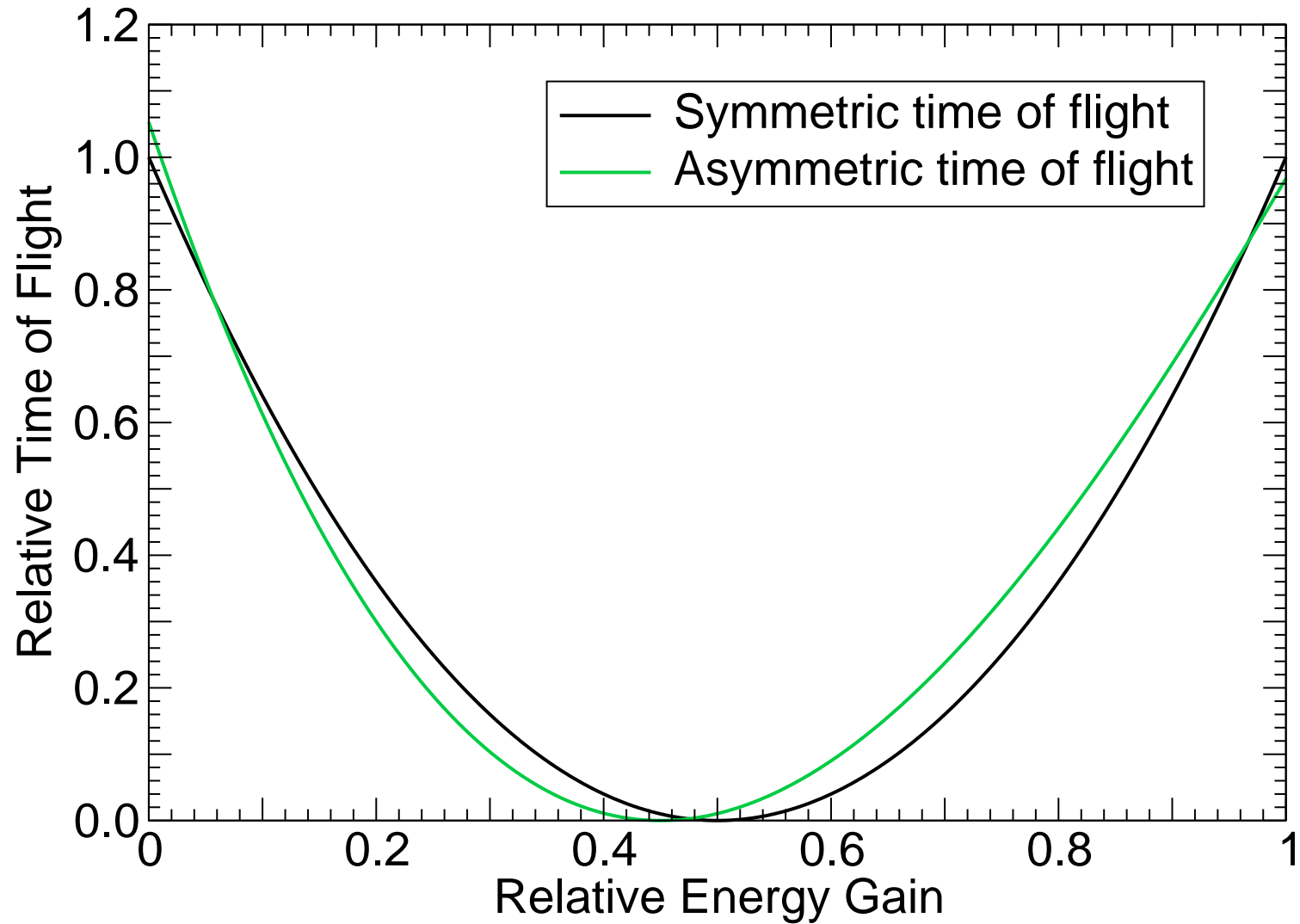
Future Work

- This is all just the beginning
  - Simultaneously optimize with several parameters (b in particular)
  - Look at time in machine as well (decays)
- Most important use of this is for time of flight dependence on transverse amplitude
  - Look at effects on several amplitudes simultaneously
  - Optimize together